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$\left\{ \frac{2np \Delta}{apm+bn-clp+cm}, \frac{2n \Delta}{apm+bn-clp+cm}, -\frac{2 \Delta (lp-m)}{apm+bn-clp+cm} \right\}$ are the co-ordinates of C ;

$\left\{ 0, \frac{2 \Delta (qn-1)}{b(qn-1)+cmq}, \frac{2 \Delta mq}{b(qn-1)+cmq} \right\}$ are the coordinates of B ;

$\left\{ \frac{2 \Delta (qn+1)}{a(qn+1)-qcl}, 0, -\frac{2 \Delta ql}{a(qn+1)-qcl} \right\}$ are the coordinates of D .

$a mq + \beta pmq - \gamma p(qn-1) = 0$, is the line through AB ;

$a nql - \beta (qmn + m - lp) + \gamma n(qn+1) = 0$, is the line through CD .

Comparing, we get $q=0$ or $q=- (1/n)$, $p=m/l$ or $p=0$. There are no positive values for q when p is positive. When p is positive, $q=0$, etc.

Whatever relations we establish we cannot find p and q both real or both positive.

CALCULUS.

286. Proposed by R. D. CARMICHAEL, Princeton University.

Solve the differential equation

$$\begin{aligned} & [a_0 x^3 + a_1 x^2 y + a_2 x y^2 + (a_0 - a_1 + a_2) y^3 \\ & \quad + a_3 x^2 + a_4 x y + a_5 y^2 + a_6 x + a_7 y + a_8] dx \\ & + [a_0 y^3 + a_1 x y^2 + a_2 x^2 y + (a_0 - a_1 + a_2) x^3 \\ & \quad + a_3 y^2 + a_4 x y + a_5 x^2 + a_6 y + a_7 x + a_8] dy = 0. \end{aligned}$$

No solution of this problem has been received.

287. Proposed by C. N. SCHMALL, 604 East 5th Street, New York City.

An object P , being placed beyond the principal focus F of a convex lense, determine its position when its distance PQ , from its image Q , is a minimum.

Solution by G. B. M. ZERR, A. M., Ph. D., Philadelphia, Pa.

Let u =distance of object from lense, v =distance of image from lense, t =thickness of lense, and r, s =the radii of the first and second surface.

Then $\frac{1}{\frac{1}{v} + \frac{\mu-1}{s}} + \frac{1}{\frac{1}{u} - \frac{\mu-1}{r}} = \frac{t}{\mu}$, where μ =index of refraction, or

$$\mu \left(\frac{1}{u} + \frac{1}{v} \right) = \left(\frac{1}{r} - \frac{1}{s} \right) \mu (\mu - 1) + t \left(\frac{1}{v} + \frac{\mu-1}{s} \right) \left(\frac{1}{u} - \frac{\mu-1}{r} \right) \dots (1).$$

$$u+v+t=\text{minimum... (2)}.$$

$$\mu \left(\frac{du}{u^2} + \frac{dv}{v^2} \right) = t \left(\frac{1}{u} - \frac{\mu-1}{r} \right) \frac{dv}{v^2} + t \left(\frac{1}{v} + \frac{\mu-1}{s} \right) \frac{du}{u^2}. \quad du+dv=0.$$

$$\therefore \left(\mu - \frac{t(\mu-1)}{r} \right) u^2 + tu = \left(\mu + \frac{t(\mu-1)}{s} \right) v^2 + tv.$$

The value of v from this equation in (1) gives the value of u .

If t , the thickness of the lense, be neglected, we get $u=\pm v$.

This in $\frac{1}{u} + \frac{1}{v} = (\mu-1) \left(\frac{1}{r} - \frac{1}{s} \right) = \frac{1}{f}$, gives $\frac{2}{u} = \frac{1}{f}$, or $u=2f=v$.

Taking the formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$, $u+v=\text{minimum}$, we get

$$\frac{du}{u^2} + \frac{dv}{v^2} = 0. \quad du+dv=0.$$

$\therefore u=\pm v$ and $u=2f=v$, as before. The object and image are both twice the focal distance from the lense.

Also solved by C. N. Schmall.

288. Proposed by L. H. McDONALD, M. A., Ph. D., Sometimes Tutor at Cambridge, Jersey City, N. J.

$$\text{Find } \int \frac{x dx}{(1+x^3)^{\frac{2}{3}}}.$$

Solution by G. B. M. ZERR, A. M., Ph. D., Philadelphia, Pa.; FRANCIS RUST, M. S., Pittsburg, Pa.; and V. M. SPUNAR, Pittsburg, Pa.

$$\text{Let } 1+x^3=x^3z^3. \quad \text{Then } \frac{x dx}{(1+x^3)^{\frac{2}{3}}} = - \int \frac{dz}{z^3-1} = u.$$

$$\text{Hence, } u = -\frac{1}{3} \int \frac{dz}{z-1} + \frac{1}{3} \int \frac{(z+2) dz}{z^2+z+1} = \frac{1}{6} \log \left[\frac{z^2+z+1}{(z-1)^2} \right] + \frac{1}{\sqrt{3}} \tan^{-1} \left[\frac{2z+1}{\sqrt{3}} \right]$$

$$= \frac{1}{6} \log \left[\frac{(1+x^3)^{\frac{2}{3}} + x(1+x^3)^{\frac{1}{3}} + x^2}{(1+x^3)^{\frac{2}{3}} - 2x(1+x^3)^{\frac{1}{3}} + x^2} \right]$$

$$+ \frac{1}{\sqrt{3}} \tan^{-1} \left[\frac{2(1+x^3)^{\frac{1}{3}} + x}{x\sqrt{3}} \right].$$

Also solved by J. Scheffer, S. G. Barton, and C. N. Schmall.

S. Lefsehetz and V. M. Spunar should have been credited for solving 284 and 285 in last issue.